

School of Engineering

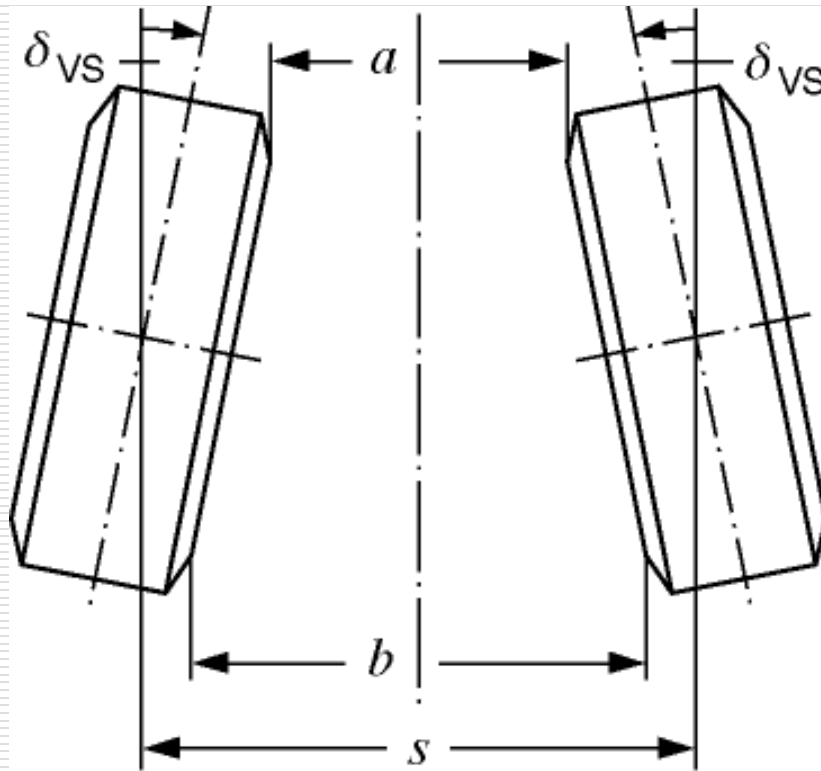
Introduction to vehicle suspension Wheel Alignment

Mark Sandford

What must a vehicle suspension do ?

- ❑ Suspension hardware must
 - ❑ Allow vertical movement of the wheel and tyre
 - ❑ Minimise changes to wheel alignment during the vertical wheel travel
 - ❑ Allow sufficient angular articulation of the steering wheels
 - ❑ Minimise changes to wheel alignment during the angular wheel travel
 - ❑ “Let nothing steer the wheels but the steering” - Colin Chapman
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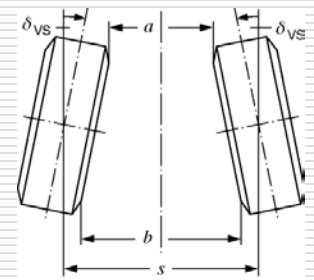
Suspension toe



Toe-in

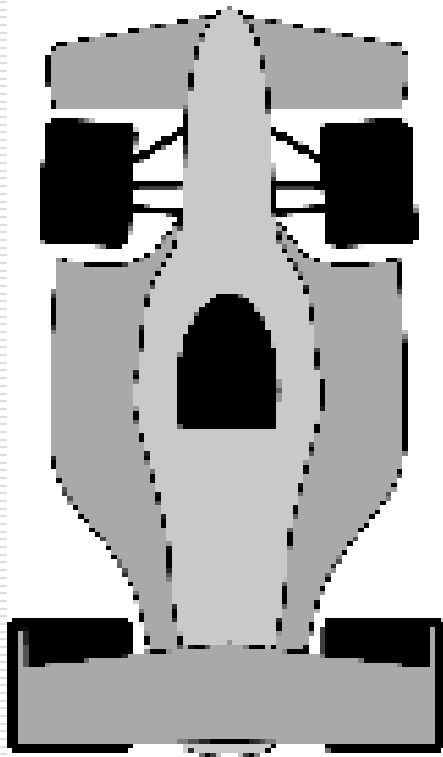
δ_{vs} Toe-in angle,
Distance between wheels:
a Front
b Rear
b-a Toe-in (in mm),
s Track.

Toe-in

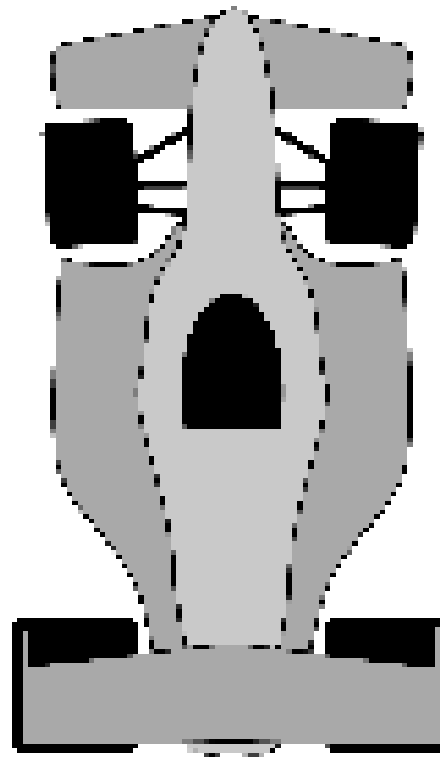


- ❑ Is the angle between the vehicles longitudinal axis and a plane through the tyre centre
 - ❑ It can also be defined as the distance between the front and rear of the wheel rim.
 - ❑ On the front steering wheels typical values are:
 - ❑ Rear wheel drive, front toe-in 5-20 minutes
 - To provide straight line stability
 - ❑ Front wheel drive, front toe-out 0-20 minutes
 - To compensate for motive forces
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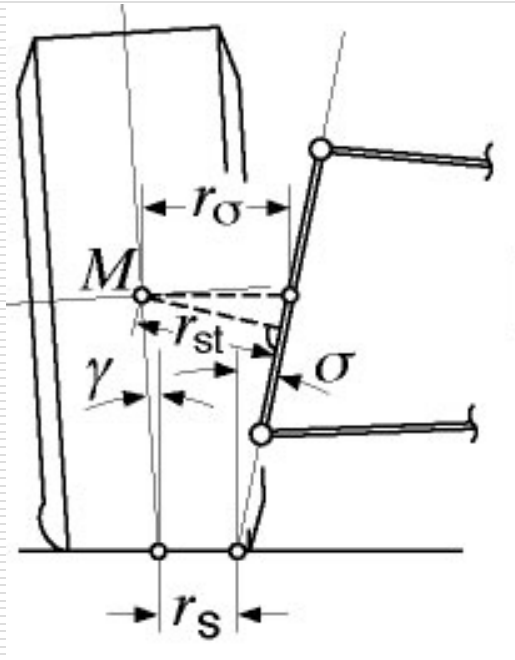
Toe-in



Toe-out



Wheel position – King pin



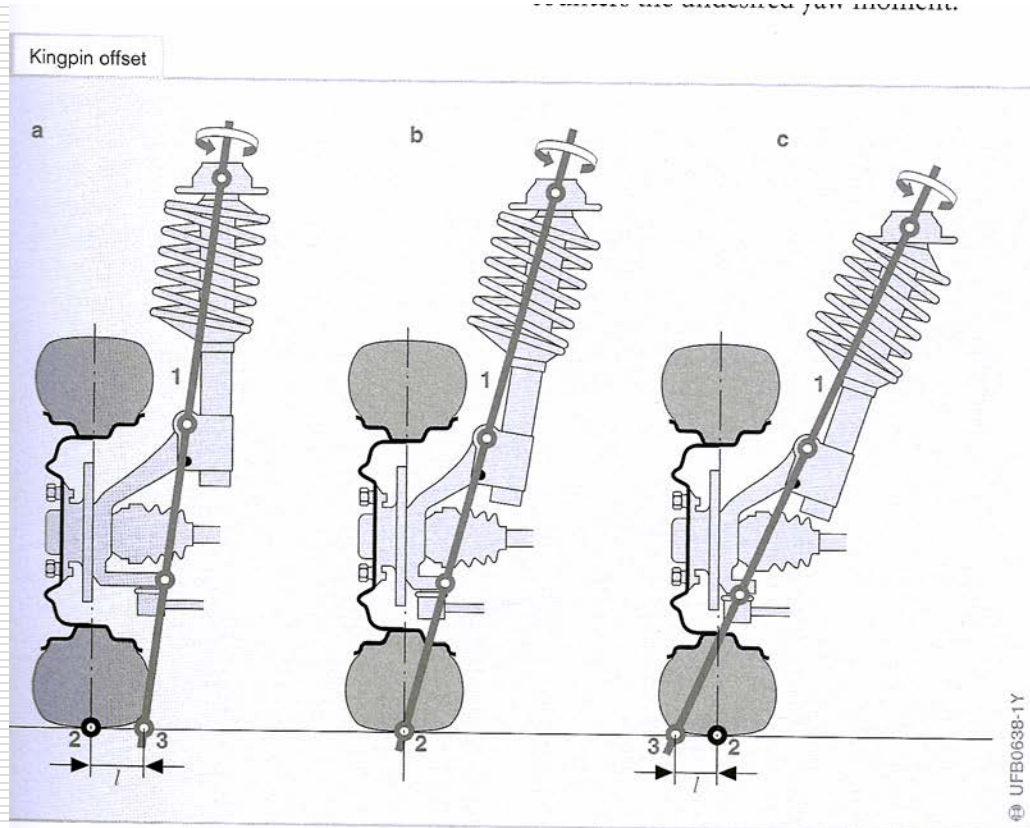
r_s Kingpin offset or steering offset
Distance between the wheel contact point and where the steering axis hit the ground

σ Kingpin angle.

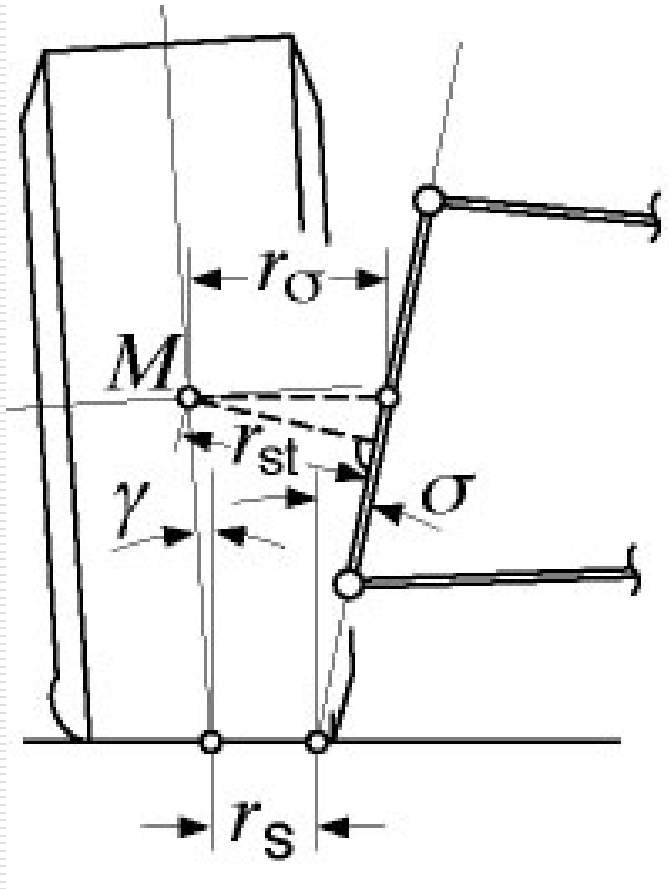
Difference between the steering axis and the vehicle longitudinal plane.

The kingpin offset combines with the effect of traction and braking forces to generate loads on the steering and effects steering forces
And feel

King Pin Offset



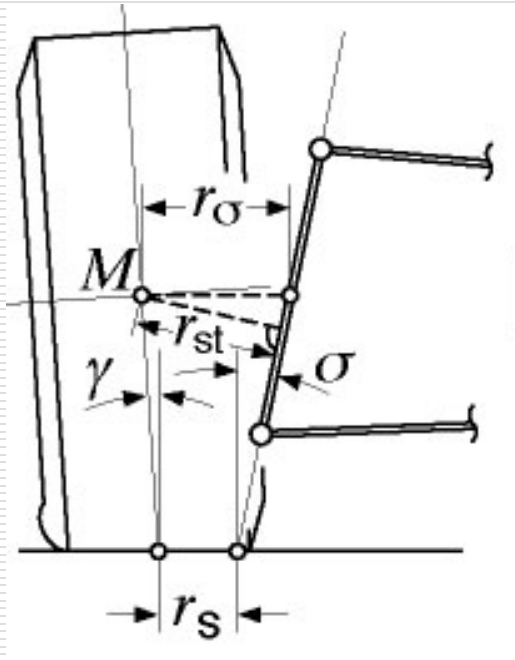
Wheel position – camber



Wheel position.

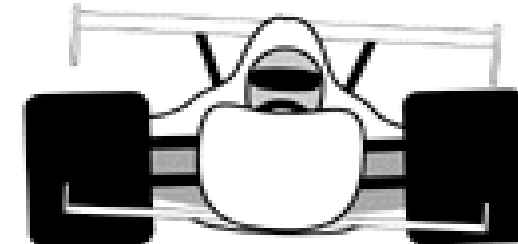
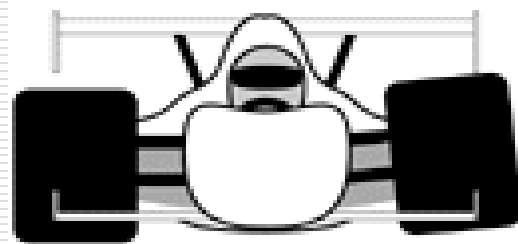
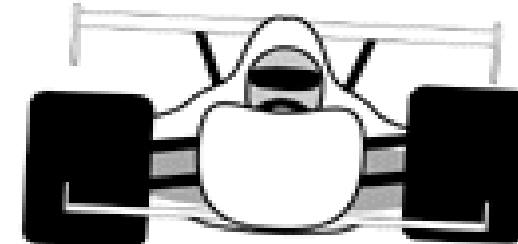
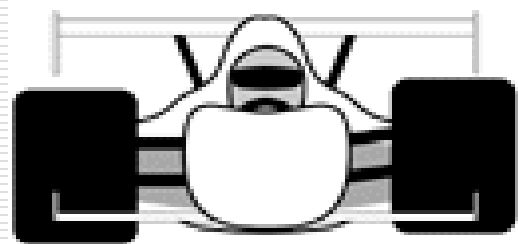
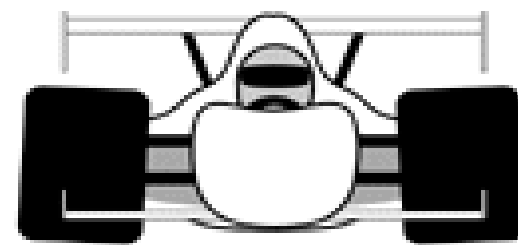
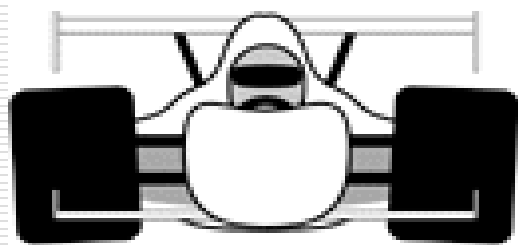
M Center of wheel,
 r_{σ} Radius of deflection
leverage,
 nt Caster offset,
 n Positive caster,
 τ Caster angle,
 r_{σ} Kingpin inclination
offset,
 r_s Kingpin offset,
 γ Camber angle,
 σ Kingpin angle.

Wheel position – Camber



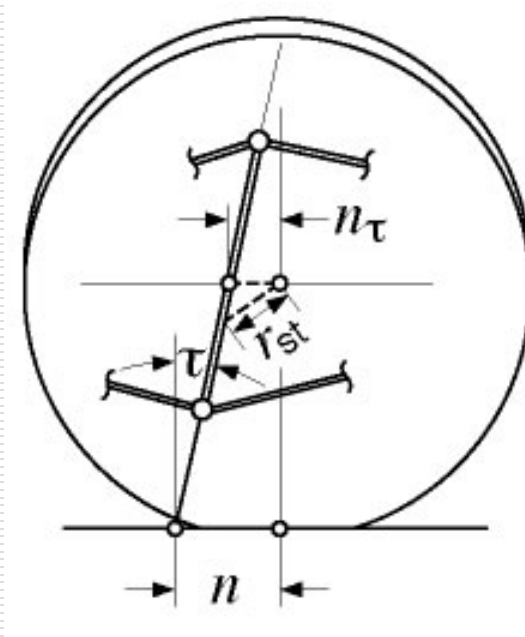
γ Camber angle,
Inclination of wheel axis in relation to
the road surface in a vertical plane
The angle is considered –ve when the
top of the wheel is angled towards
the centre of the vehicle.

Camber
creates small auxiliary side forces
compensates for the effects of roll angle during cornering





Wheel position – caster



n Positive caster,
Distance from wheel contact point to
where the point of the steering axis
hits the road

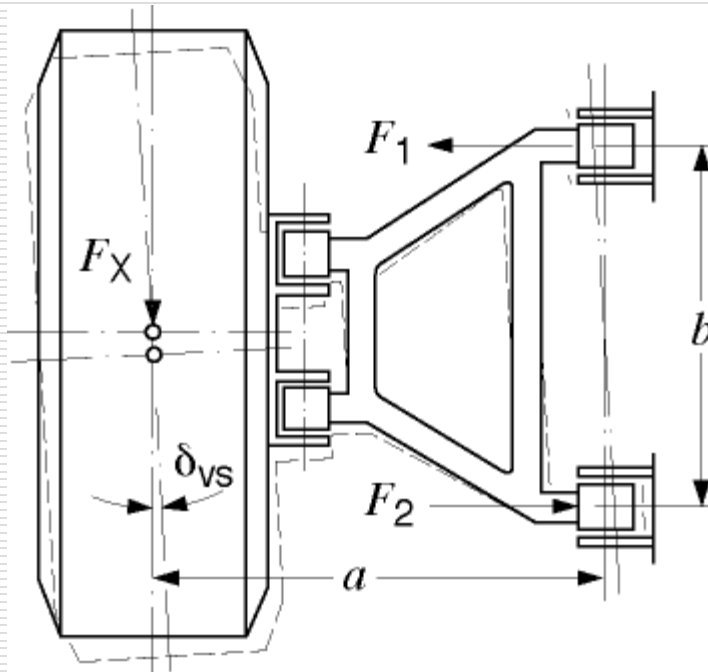
τ Caster angle,
The angle from the steering axis
(viewed from the side) and the
vertical

Caster

Determines the degree of self centering action of the steering
Influences straight running
Influences steering forces when cornering

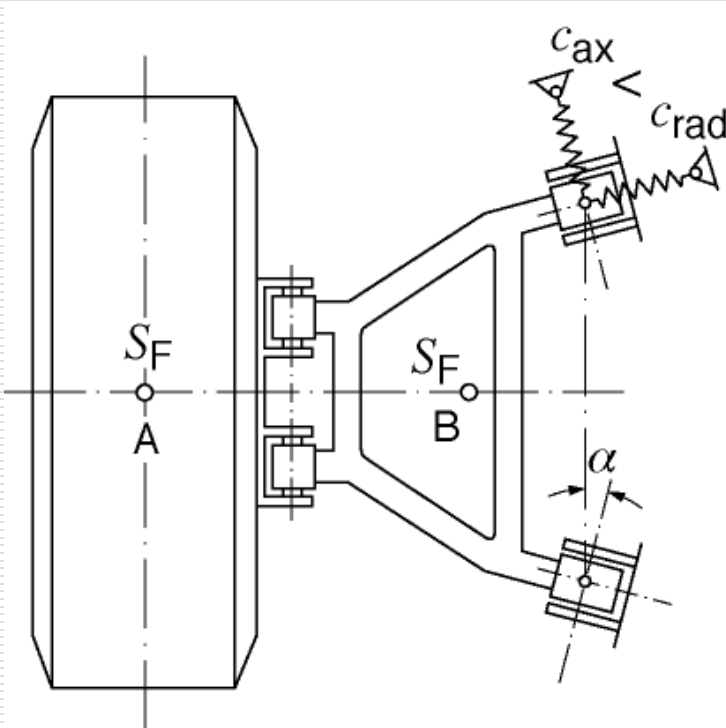


Suspension



Wheel displacement by longitudinal force F_x .
 F_1, F_2 Suspension-arm mounting forces,
 a Distance between wheel axes and suspension arm,
 b Suspension arm mounting separation,
 δ_{vs} Toe-in angle.

Suspension



Positioning of suspension-arm mountings to counteract steering deflection due to flexibility

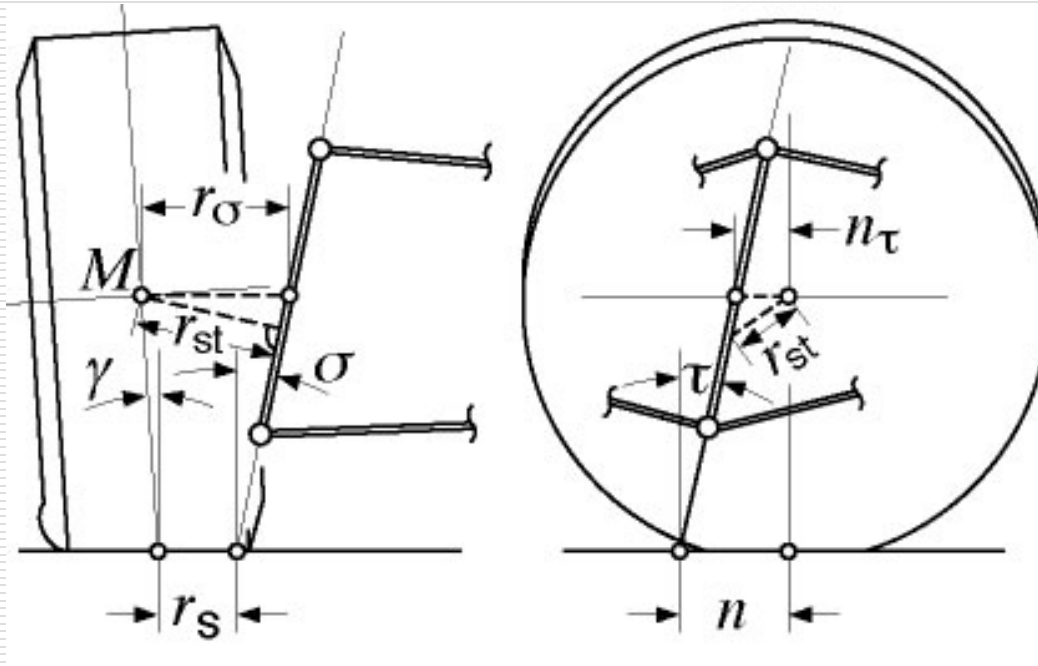
SF Center of gravity (A Reduction, B Complete equalization),
 c_{ax} c_{rad} Axial/radial spring constants,
 α Alignment angle.

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Camber and caster



Wheel position.

M Center of wheel,
 r_{st} Radius of deflection leverage,
 n Caster offset,
 n Positive caster,
 τ Caster angle,
 r σ Kingpin inclination offset,
 r_s Kingpin offset,
 γ Camber angle,
 σ Kingpin angle.